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Transforming the NextGen Test Environment: Integrating Fused ADS-B Surveillance Data, Phase I Seedling Effort

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NASA Aeronautics Research Mission Directorate (ARMD)

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Outline

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- Background
- Innovation
- Technical Approach
- Results of Seedling Phase I Effort
- Impact
- Distribution/Dissemination
- Next Steps – Phase II Proposal
- Concluding Remarks



Phase I Background

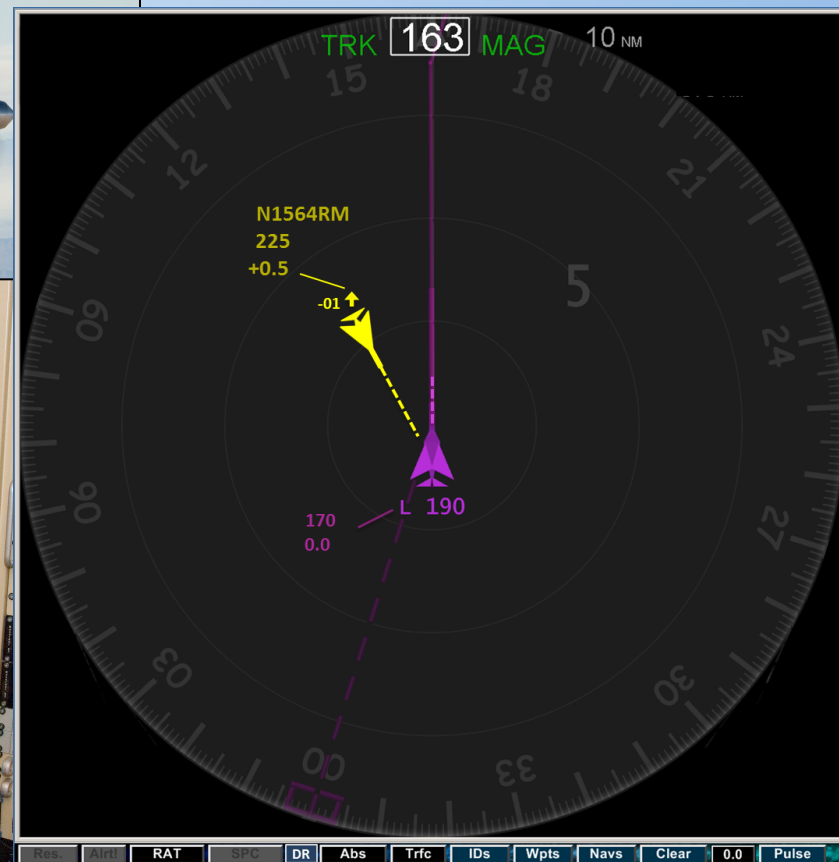
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- NASA Air Traffic Management (ATM) research has historically focused on Instrument Flight Rules (IFR) flights – those under ATC control
- NASA now addressing integration of Unmanned Aircraft Systems (UAS) into National Airspace System (NAS)
- UAS may operate in same airspace as Visual Flight Rules (VFR), general aviation flights – those not under ATC control
- UAS operator situational awareness enhanced by display of position of all flights in vicinity, including VFR
- Inclusion of VFR flights also increases fidelity and credibility of scenarios used for UAS-NAS R&D
- Access to VFR flight data was minimal across NASA



UAS-NAS Integration

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The Innovation

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- Enable simulation and flight testing of UAS-NAS integration concepts with accurate representation of all traffic in vicinity
- Provide high-fidelity NASA dataset of US air traffic:
 - Includes all traffic, VFR and IFR, for entire NAS
 - Presents best available accuracy and high update rate for each flight track
- Set stage for Phase II two-way data sharing between UAS and NAS:
 - Enable real-time NAS surveillance data availability to UAS operators and NASA research environment
 - Ability to insert real-time positional information for UAS of all sizes and equipage into NAS



Technical Approach

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- Partner with Exelis Corp. to obtain NextGen fused data product and graphical application
- Process and insert data into Oracle data warehouse
- Assess data quality for consistency, availability, and accuracy
- Cleanse data using wide array of constraints and rules
- Provide web interface enabling data download in multiple formats
- Create UAS simulation scenarios from downloaded data

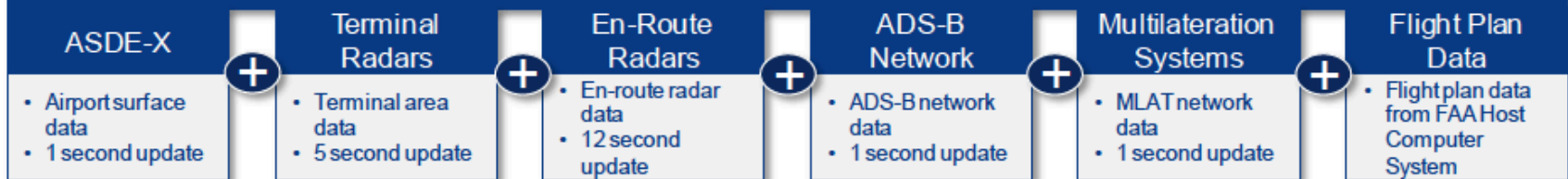


Exelis NextGen Fused Data

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One Aircraft Target...One Track...One Point of Contact...Nationwide

Surveillance Data Fused from Multiple FAA ATC Systems

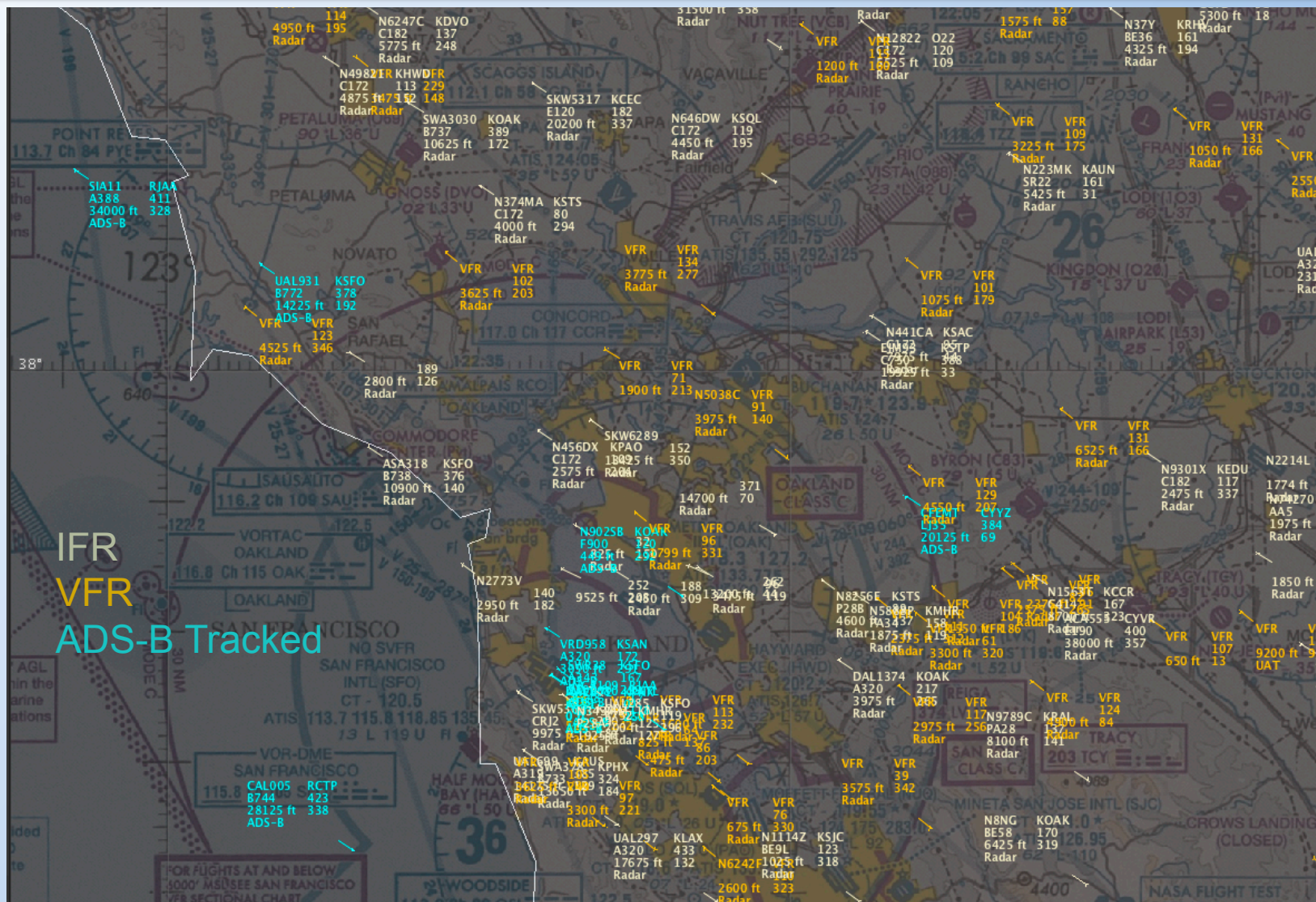


- Fuses many sources, from surveillance radars to GPS-based ADS-B output
- Correlates track data over time for gate-to-gate records of individual flights
- Chooses best available source at each track update, for optimum accuracy
- Less than 1 second latency to client delivery



NextGen Data Coverage

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NextGen Data Content

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Object properties (NAS View)

☐ Quick-Display features ☒ All features

Feature name	Value
Origin	KLAX
Destination	RJAA
Runway	
Mode-S	76CD70
Adviseable	false
Long	-123.0059127807617
Lat	37.98994827270508
Alt	34,000 ft
Heading	338
Airline	SIA
Airport	
Vehicle Type	HEAVY
On Ground	false
In Movement Area	false
Taxi Timer	--:--
ETD	31/14:34
ETA	01/01:24
Route	KLAX.VTU5.RZS..LIBB...
Departure Fix	RZS

Tracking Source	ADS-B
ETD - Published	31/14:15
ETA - Published	01/02:05
OFF - Scheduled	31/14:34
OFF - E/A	A31/14:34
IN - Scheduled	31/14:15
IN - E/A	E01/01:35
OUT - Scheduled	31/14:15
OUT - E/A	A31/14:16
ON - Scheduled	01/01:29
ON - E/A	E01/01:24
Block Time - Scheduled	11:50
Block Time - Actual	
ACTYPE - Schedule	
Gate - Departure	
Terminal - Departure	B
Gate - Arrival	
Terminal - Arrival	1
Ground Speed	423
Beacon Code	1022

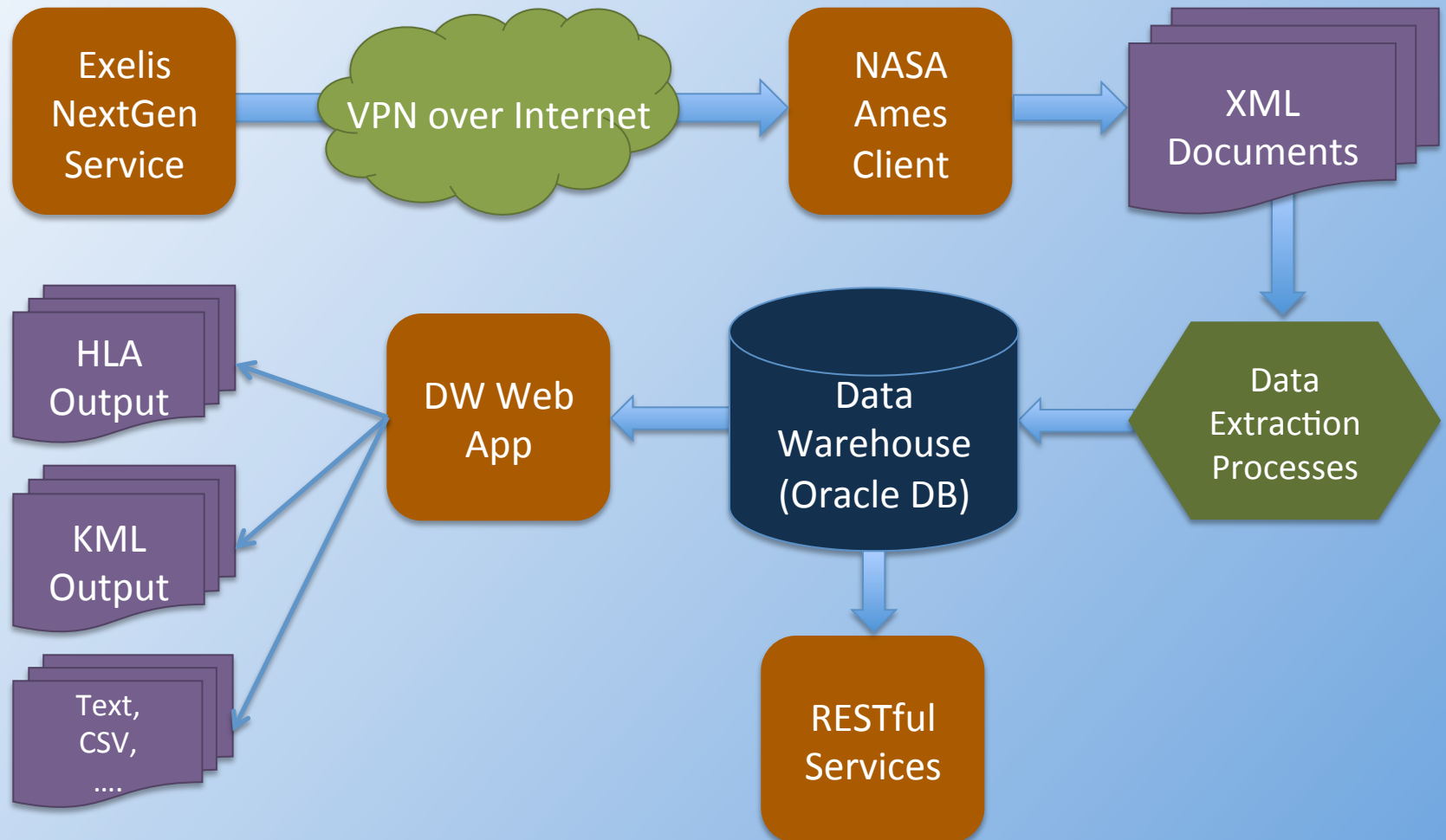
NAS View

Mercator 1 : 564,718



Exelis Data Processing

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Data Quality Analysis

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- 42 continuous days of NextGen data collected March/April 2013
 - Nationwide feed of all airborne flights
 - Surface data for Charlotte and Phoenix airports
- Data stream provides flight information and track messages, correlated with each other
- Extensive processing using domain-based rules identifies data anomalies



Data Quality Issues

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- Incorrectly correlated flights
 - Unexpected events during flight operation
 - Changing tail number, aircraft type, or Mode S code
 - Missing call-sign
- Mismatched FAA flight plan and track data for multi-leg flights
 - Future flight plan confused with current one
 - Especially true for airlines that leave transponders on while flying multiple legs



Data Processing Results

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Data Statistics	Number of Flights	Track Data Points
Raw data (42 days)	7.7 million	2.7 billion
Usable data	6.2 million	2.5 billion
% Usable data	80%	94%

- NASA's detailed analysis of data quality resulted in improvements to NextGen product
 - More complete data set now available to commercial customers and researchers
 - Future data collection periods will have higher percentage of usable data



Other Flight Statistics

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Flight Statistics	Percentage of Flights	Percentage of Tracks
VFR Flights	68%	25%
ADS-B Equipped	19%	
IFR and ADS-B Equipped	16%	



- Results provide visibility into mix of aircraft operations and equipage in NAS
- ADS-B expected to increase significantly through 2020



Data Warehouse Interface

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Exelis Flight Data Search

Track Date-Time UTC Between  **and** 

☐ No Boundary (covers entire NAS)

Track ☒ Airport Area (square area)

Boundary: ☐ Area of Interest (rectangular area)

☐ User Defined Rectangular Area

IFR / VFR: ☒ All (IFR & VFR flights)

☐ IFR Flights Only (flight plan filed)

☐ VFR Flights Only (flight plan not filed)

ADS-B: ☐ Specific Aircrafts equipped with ADS-B

Callsign: ☐ Specific Aircrafts with Callsign

AC Type: ☐ Specific Aircrafts with Aircraft Type

ADS-B

Trx. Min. %

Threshold:

Download Option:

☐ Count Flight Records Only

☐ Preview Flight Records Only

☐ CmSim file: IFR flights only


☐ CmSim file: VFR flights only (AC_DATA)

☒ HLA CSV file

☐ Track Only CSV file

☐ Google Earth KML file

Airport Area



Distance (NM) From Center

Final Flight Plan (regex)

Mode-S Code (regex)

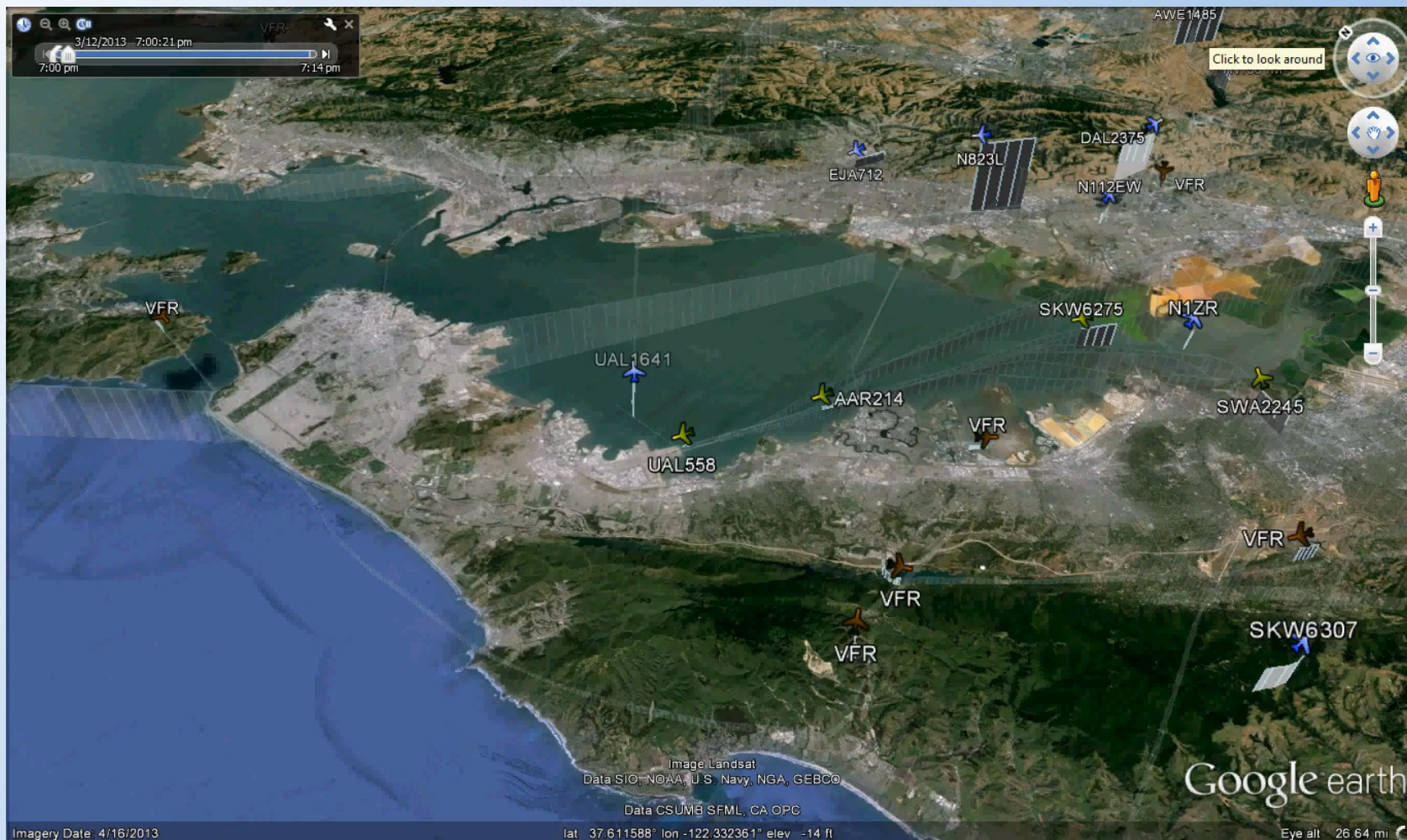
Callsign (regex)

Aircraft Type (regex)



Visualization in Google Earth

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Realized Impact

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- Integration of VFR traffic enhanced quality of UAS-NAS simulation scenarios
- NASA data analysis and feedback facilitated enhancements to Exelis NextGen data delivered to commercial users and researchers
- GPS-sourced track data enabled study of impact of better state accuracy on ATM automation
- Data warehouse with enhanced data set available to NASA researchers who require traffic information for any number of local or national air traffic analyses



Distribution/Dissemination

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- NASA and its ATM/UAS partners have access to NextGen data in Oracle data warehouse
- NASA Technical Memorandum in progress regarding Phase I efforts
- Conference papers planned for Phase II, if selected



Phase II Transition

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- Phase I Complete
 - More realistic NAS representation now available to NASA ATM and UAS researchers
 - Filled a critical gap in NAS research data set
- Phase II Objective: Enable two-way data sharing between a UAS ground control station and NAS
 - Real-time NAS surveillance data available to UAS operators and NASA research environment
 - Insertion of real-time positional information for UAS of all sizes and equipage into NAS

IMPACT: NASA, in collaboration with industry, will create a path to further enable safe and effective integration of UAS into NAS through two-way data sharing



Phase II Concept

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Large UAV



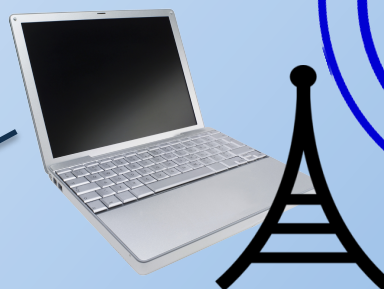
Small UAV

Line-of-sight
position data

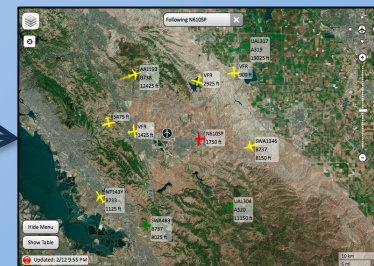
ADS-B out



Internet

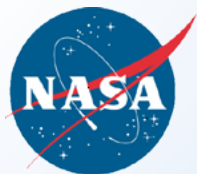


All traffic sent
to ground
stations



Exelis NextGen
System

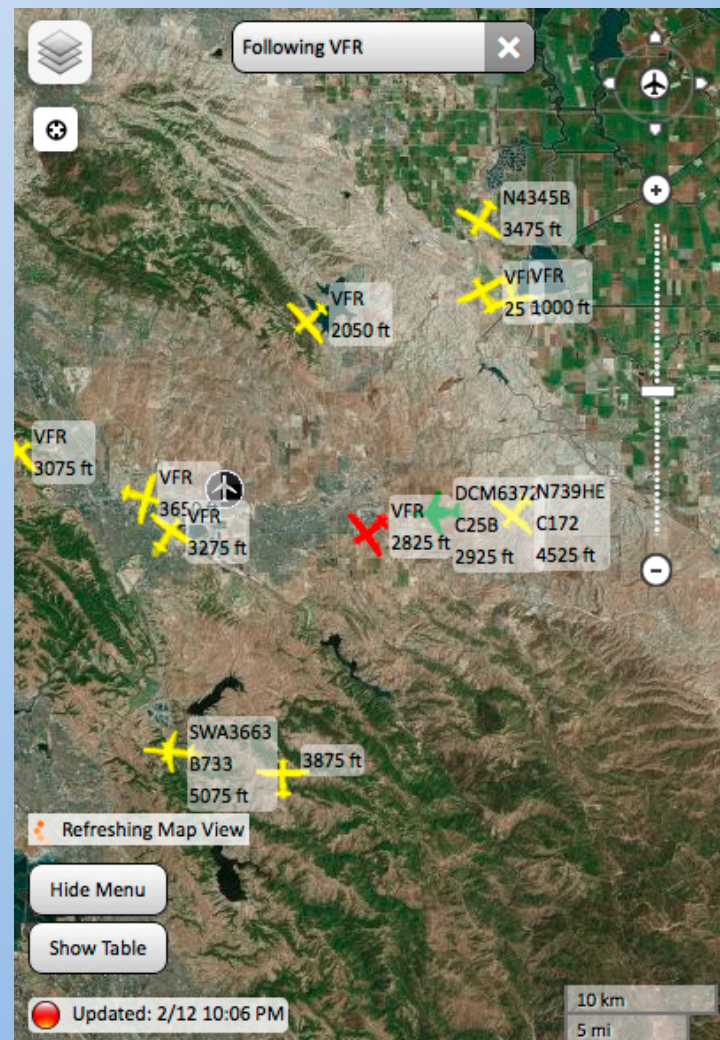




Phase II Enabling Technology

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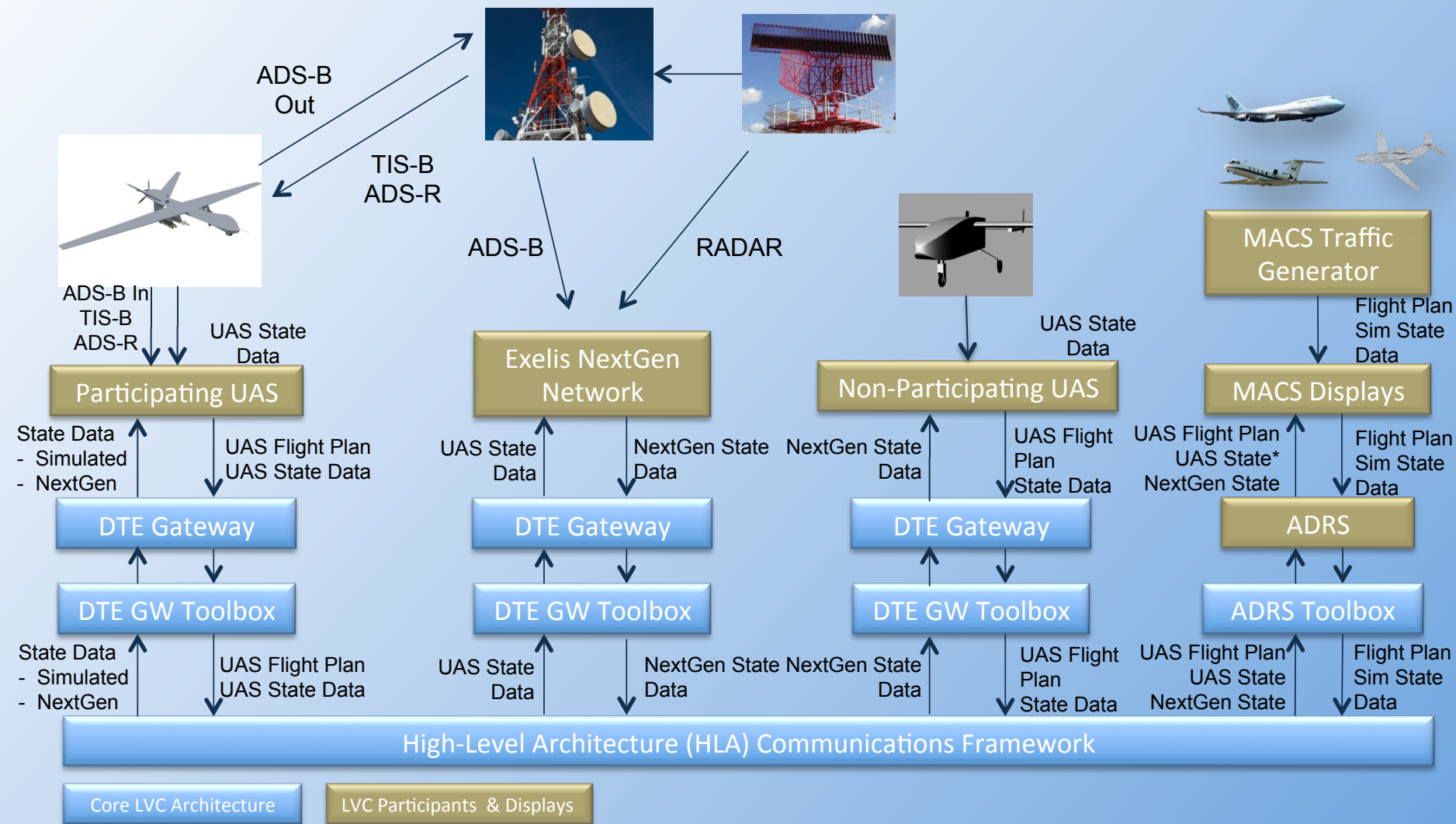
- Exelis MobileVue App
 - Internet-based delivery of NAS data
 - Traffic awareness on mobile devices using cellular bandwidths
- Potential traffic situation display for small UAS operations





Phase II Architecture

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Concluding Remarks

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- Phase I Seedling Fund effort resulted in two new capabilities for NASA:
 - NAS-wide data set representing all traffic now available to NASA ATM and UAS researchers
 - Filled critical gap in NAS research data set and provided ability to create more realistic simulation scenarios
- Phase II promises to further enable safe and effective integration of UAS into NAS through two-way data sharing
 - Ability for UAS without transponders to see and be seen by other aircraft